

Is Religious Education Compatible With Science Education?

MARTIN MAHNER and MARIO BUNGE

Foundations and Philosophy of Science Unit, McGill University, 3479 Peel Street, Montreal, Canada H3A 1W 7

ABSTRACT: This paper tackles a highly controversial issue: the problem of the compatibility of science and religion, and its bearing on science and religious education respectively. We challenge the popular view that science and religion are compatible or even complementary. In order to do so, we give a brief characterization of our conceptions of science and religion. Conspicuous differences at the doctrinal, metaphysical, methodological and attitudinal level are noted. Regarding these aspects, closer examination reveals that science and religion are not only different but in fact incompatible. Some consequences of our analysis for education as well as for education policy are explored. We submit that a religious education, particularly at an early age, is an obstacle to the development of a scientific mentality. For this and other reasons, religious education should be kept away from public schools and universities. Instead of promoting a religious world view, we should teach our children what science knows about religion, i.e., how science explains the existence of religion in historical, biological, psychological and sociological terms.

INTRODUCTION

A science education and an education of science teachers that does not confine itself to the conveyance of factual knowledge but attempts to give serious consideration to the history and philosophy of science will have to address, among other issues, the metaphysical or ontological presuppositions of science (Woodger 1929; Burt 1932; Bunge 1977, 1979a, 1989b; Matthews 1992). After the decline of positivism, for which metaphysical questions were nonsensical, it is now – some surviving empiricists aside – generally acknowledged that science presupposes a wealth of metaphysical assumptions. The question, however, arises what kind of metaphysics science does actually presuppose.

It seems so obvious that a naturalist-materialist outlook is pervasive in science that some authors (e.g., Settle 1990) of a different persuasion feel compelled to warn against the explicit endorsement of this kind of metaphysics. Furthermore, a case can be made for a broader ontology including a religious outlook: Many scientists obviously not only embrace naturalism but also hold religious beliefs. (Even if they don't, only a few dare to be outspoken atheists: see, e.g., Dawkins 1993.) This holds not only for scientists of old like Newton, Boyle, Faraday, or Maxwell, but also for many contemporary ones, although their beliefs may be rather fuzzy and abstract (see, e.g., the different statements in Margenau and Varghese (eds.) 1992). It seems only consistent then, from a philosophical and historical point of view, to demand not to ignore the religious beliefs

of great scientists when teaching their scientific accomplishments (Woolnough 1991; Matthews 1991, 1992). The case of religious scientists seems to support the view, which is also held by the majority of modern theologians as well as some philosophers (see, e.g., Rolston 1987; O'Hear 1993), that science and religion, if properly understood, are not incompatible as the implicit materialist outlook of science, as well as the long history of the warfare of science with religion – in particular Christian theology – might suggest. (For an early extensive historical account of this warfare see White 1896.) An entire journal – *Zygon* – is devoted to the examination of the relationship between science and religion.

Given this commonly held view it also seems unproblematic to most of us that our children not only are taught a scientific curriculum at school but at the same time, and often in the same institution, also receive a religious education. Under religious education we understand an education under clearly denominational auspices, however liberal. That is, students are not just taught some unbiased comparative, historical, philosophical, cultural, and social aspects of religion but are supposed to accept and internalize some or all of the doctrines of a particular religious belief system, usually the one their parents are affiliated to.

Contrary to those widely held beliefs, we will defend here not only the thesis that a religious education is detrimental to a scientific one but also the thesis that science and religion are incompatible. (A similar view, though without a closer analysis, has recently been expressed by Suchting 1994.) Now, it is possible to reject religious education while holding the view that science and religion are compatible. For example, one could reject religious education in the sense outlined above arguing that a person should be able to freely choose his or her religion, if at all, when intellectually mature instead of becoming indoctrinated with a particular view at an early age. After all, only a minority of people change their beliefs in adulthood, a clear indicator that indoctrination and habituation are the main sources for holding a certain religious belief. However, we will argue the other way round, that is, we shall claim that science and religion are perpendicular to each other, whence the incompatibility of religious and science education is a mere corollary.

In doing so, we are aware that an examination of the compatibility or incompatibility of science and religion would deserve a whole monograph (see, e.g., Clements 1990). However, we contend that even a brief examination of the difference between science and religion will suffice to substantiate our claim. (See also Smart 1967; Bunge 1983b, 1988; Tuomela 1985; Rachels 1991; Wolpert 1992; Suchting 1994.)

SCIENCE

Among philosophers of science there is no agreement as to how to characterize science, particularly, as how to demarcate it from nonscientific fields

of inquiry. Since we cannot engage in this debate here, we just offer our own characterization of science, which is supposed to hold foremost for *modern science*, i.e., the science of our times, and not necessarily for 17th century science (Bunge 1983b, 1988). Disregarding *formal sciences* such as logic and mathematics, we characterize *factual science* as a whole (rather than a particular science), at any given time, as the 9-tuple

$$SCIENCE = \langle C, S, D, G, F, P, K, A, M \rangle,$$

where C = The international community of scientific investigators or scientific community; S = The societies hosting and tolerating C ; D = The domain of facts (or universe of discourse) studied by the members of C ; G = The general outlook, or world view, or philosophy held by the members of C in their capacity as researchers; F = The formal background, i.e., the totality of logical and mathematical theories known at the given time; P = The problematics, i.e., the collection of cognitive problems that can be handled scientifically at the given time; K = The body of knowledge, i.e., the collection of data, hypotheses, and theories, available at the given time; A = The aims of research, i.e., the discovery or utilization of objective laws and true theories capable of systematizing, explaining, or predicting; and M = The methodics, or collection of all methods (often misnamed 'methodology') utilizable in science.

The precise membership of every one of the nine coordinates of *SCIENCE* changes in the course of time: science is essentially dynamic. Moreover, the evolution of scientific knowledge is the result of research not of external pressures: the latter can only accelerate or slow down a research process that has an internal dynamics. Another characteristic of science is that it constitutes a system every subsystem of which (e.g., physics, biology, or social science) is tightly connected to some other subsystem of science. Thus, if a discipline makes no contact with other disciplines then it is not a science. Witness parapsychology and psychoanalysis.

Some of the nine components used to characterize science as a whole deserve further explication: The reference to the scientific community C and the societies S hosting C reminds us that science is a social activity rather than a collection of self-existing cognitive items.

The *domain* D of factual science comprises everything existent, i.e., the whole world. Although there are certainly things that are *de facto* beyond scientific investigation for lack of information, there is nothing that could not be *de jure* studied scientifically. As a matter of principle, the domain of science also includes, for instance, the how and why of subjective feelings and emotions as well as the origins and function of morality and religion – fields of inquiry that are sometimes believed to be beyond scientific understanding.

The *general outlook* or *viewpoint* G of science comprises a naturalist ontology (or metaphysics), a realist epistemology, and a system of internal values (or endoaxiology) that is particularly characterized by the ethos of

the free search for truth. The internal value system of science includes such *logical* values as exactness, systemicity, and logical consistency; *semantical* values such as meaning definiteness (hence clarity) and maximal truth (or adequacy of ideas to facts); *methodological* values such as testability and the possibility of scrutinizing and justifying the very methods employed to put ideas to the test; and, finally, *attitudinal* and *moral* values such as critical thinking, open-mindedness (but not blank-mindedness), veracity, giving credit where credit is due, and more. The endoaxiology of science is often called 'the ethos of science' (Merton 1973).

(Clearly, some scientists fail to cherish one or more of these values. This, however, does not indicate that the endoaxiology of science is irrelevant or that scientific research is irrational, as it has been held by critics of science. After all, even bad scientists are part of the scientific community, so much so that if they themselves fail to realize their shortcomings or mistakes their peers will not hesitate to expose their flaws. Self-correction is one of the hallmarks of science. Furthermore, such cases just show how necessary it is to make the internal value system of science explicit and to make its adoption an ideal of science education (see also Siegel 1989).)

Basic science is value-free only in the sense that it does not make value judgments about its objects or referents. That is, basic science has no external value system or exoaxiology. As soon as the objects of science are assigned any value or disvalue for a certain purpose we arrive at applied science or technology.

The *fund of scientific knowledge* *K* is a growing body of factual knowledge, in particular laws.

The *methodics* *M* includes, in the first place, the scientific method as the most general strategy of scientific research. Since the existence of a general scientific method has been doubted by some philosophers of science, among them Popper, we should assert that the scientific method may be conceived of as consisting of the following ordered sequence of cognitive operations: Identify a problem – search for information, methods instruments – try to solve the problem with the help of those means – if necessary invent new means, produce new data, or design new experiments – derive the consequences of your solution (e.g., predictions) – check the solution (e.g., try to replicate your findings by alternative means) – correct the solution if necessary in repeating the cycle – examine the impact of the solution upon the body of background knowledge, and state some of the new problems it gives rise to (Bunge 1983a). Less general methods are, for example, the experimental and the statistical method. Finally, the specific methods consist of particular techniques such as, for example, scanning electron microscopy. Such techniques must be scrutable and objective, i.e., we must know, at least partially, how and why they work.

RELIGION

To achieve a consensus on the characterization of religion is as difficult and controversial as it is in the case of science. Moreover, due to the remarkable variety of religions, every religionist is likely to object that, whatever characterization is given, it fails to do justice to his or her particular religious view. Yet we have to stick our neck out and attempt to generalize. In doing so, it will be sufficient to give a characterization that meets the important and influential religions of our time, in particular theistic religions. However, many, if not all, of our arguments will also hold for non-theistic religions. It should finally be noted that we are not interested in any sophisticated philosophical or theological conceptions of religion. We also disregard any philosophical deism. We further doubt that some fuzzy 'cosmic religious feeling' as expressed, e.g., by Einstein (1934) does constitute a religion in any significant sense. So what we are focusing on is 'ordinary life religion' and its 'ordinary' philosophical presuppositions. After all, this is the kind of religion that has the greatest impact on the societies we live in.

In former times the so-called great religions were clear cases of global ideologies: they proposed answers to questions of almost all kind, i.e., they contained world views supposed to accommodate all facts and to help attain a variety of cultural, political, and other goals. Nowadays only fundamentalists still adhere to such a globally religious outlook. Most of the great religions have come to terms with modern society and have accordingly adopted a far more modest scope, i.e., they do not offer an all-encompassing world view any longer. Cut down to this more modest size, religion may be analyzed as an 11-tuple

$$RELIGION = \langle C, S, D, G, F, B, P, K, V, A, M \rangle,$$

where C, S, D, G, F, P, K, A , and M come under the same headings as the corresponding coordinates in the previous section, although the content of these nine coordinates is largely different as will be spelled out subsequently. The new coordinate B denotes the factual background of religion, i.e., the body of factual knowledge admitted by the group of believers C . And the new coordinate V denotes the external value system or exoaxiology of the members of C , that is, a set of value judgments about the referents of religious discourse.

In the above list, C denotes a group of believers – which, if well organized, may be called a church or religious community. Contrary to the scientific community, which constitutes a genuine international community or system, the set of religionists does not form such a cohesive international community. This is because the believers in different creeds neither engage in the common pursuit of truth nor exchange their latest 'findings' of religious insights, intuitions, or revelations. They do not do any research proper and most of their doctrines are mutually exclusive. In science, on the other hand, the biologist, for instance, may very well

be interested in the results of physical, chemical, or geological research because it may have an impact on his or her scientific field.

The domain *D* of religion comprises, in addition to all religiously relevant parts of nature and society, also supernature. Of particular interest are of course the relations of natural things (especially humans) to supernatural entities, and vice versa.

The general outlook *G* consists of a supernaturalist ontology, which is a collection of doctrines about the supernatural and our relations to it. Supernatural entities may be impersonal forces such as *karma*, or more or less anthropomorphic 'persons' such as gods. (We reject the notion of a naturalist religion, though some people, for instance, John Dewey and Julian Huxley, attempted to make a case for it.) *G* usually comprises a realist epistemology, though religion is consistent with any epistemology. Finally, *G* contains an endoaxiology that seems to have only one issue in common with science: the quest for truth. However, whereas the truth looked for by religionists is absolute or ultimate, scientific truth is partial or approximate. Neither exactness nor logical consistency, neither clarity nor testability are strong in religion. Moreover, it can be asserted that many religious beliefs can only be upheld by disregarding such values. Otherwise it would not be possible to cherish the mysterious or to confess *credo quia absurdum*. A religious value that is alien to science is (blind) faith, which allows the religionist to always retreat to commitment or fideism if pressed by rational analysis (Bartley 1984). Finally, religion contains an ethos of acceptance and defense of unquestionable doctrines, i.e., dogmas. As for the latter, witness Augustine's dictum *Major est Scripturae auctoritas quam omnis humani ingenii capacitas* ('Greater is the authority of Scripture than all the powers of the human mind') (White 1896), or Paul's injunction 'Beware lest anyone cheat you through philosophy and empty deceit, according to the tradition of men, according to the basic principles of the world, and not according to Christ' (Col. 2: 8).

The formal background *F* of religion contains at most intuitive logic, never mathematics. Some religionists are even prepared to sacrifice logic if necessary to uphold certain contradictory beliefs. Granted, some modern theologians have made use of mathematical tools such as, for instance, the probability calculus, in their attempts to prove the existence of God, but their views certainly do not become part and parcel of the religious belief system of the religious community *C* at large. (For an extensive critique of such modern arguments that make use of some of the tools of analytical philosophy see Martin 1990.)

The factual background *B* of religion contains at best ordinary knowledge, never scientific knowledge. This is just because most religions are older than science. Some scientific knowledge may be compatible with religious doctrines up to a certain point, and some theologians may make use of scientific knowledge in certain arguments, but in the end this should not be necessary for the (alleged) truth of any religious doctrine. That is, religionists may try to use snippets of science to bolster their beliefs, never to check them.

The problematics *P* may contain the cognitive problem of how to get to know the supernatural. But, on the whole, it consists of practical problems such as personal conduct and salvation, the relation of the believer to the supernatural, the life of the church, and its relation to the rest of society.

The fund of knowledge *K* is a fixed or at most slowly changing collection of (untestable) doctrines and beliefs, whether conveyed by means of an oral tradition or through sacred scriptures. Whatever change in religious beliefs may appear to take place is not due to newly discovered facts, i.e. research, but is almost entirely a result of either (a) a change in the exegesis and interpretation of traditional doctrines, which, if taken literally, often are unpalatable to modern people, or (b) squabbles or even wars between rival factions in the same religious community. Hence, any substantial changes in the belief system are due to authority or external influence, not research. If genuine research takes place, such as historical investigation, this research is not accomplished by religious but scientific means even if undertaken by theologians. Accordingly, it has to be regarded as an external influence.

The external value system *V* is headed by the beliefs that some supernatural entity (the divine) is the highest value, and that the supreme duty of humans is to obey and worship it. The exoaxiology also contains value judgments about natural objects. That is, certain things, animals, fellow human beings, or their behavior respectively, may be judged as being good or evil.

The aims *A* of the believers in *C* are foremost practical. Moreover, they are ultimately, though mostly tacitly, selfish in that they consist in attaining personal advantage such as salvation or eternal life (individual or cosmic). To obey and worship the divine, or to live a virtuous life, though the explicit goal of the religious person, is, in the end, only a means to attain the blessings expected from the supernatural. All religion is ultimately anthropocentric.

The methodics *M* is a collection of practices, such as prayer, incantation, fasting, meditation, and other rituals that are supposed to connect human beings to the supernatural. As far as a cognitive aim is pursued the religious person may make use of intuition, contemplation, meditation, or revelation. There is neither use for the scientific method in general nor use for specific scientific techniques in religion. (For further examples see Clements 1990.)

WHY RELIGION IS INCOMPATIBLE WITH SCIENCE

Thus far we have listed several *differences* between science and religion. A mere difference, however, is not necessarily an incompatibility. So much so, that it is widely held that science and religion, though different, are either compatible or even mutually complementary in that they are concerned with 'different levels of reality' (whatever this may be), or

perhaps with completely different worlds, e.g., a transcendental world, in which the natural world is somehow 'included' (Kanitscheider 1993). Other authors contend that, whereas science would deal with causality, religion would be concerned with 'meaning' (Rolston 1987). If all this were actually the case, there might be no conflict indeed. Yet there *is* conflict: If there is any point to a religious belief that goes beyond just assuming a transcendental world that makes no contact with the natural world, and that goes beyond mere subjective feelings or a merely pragmatist view of religion, the religious realm must overlap with the scientific one. Only thus can humans be connected to a 'different level of reality', for example, to a supernatural or spiritual realm. We maintain that the main point of the religious belief of most religionists consists in assuming, exploring, finding or establishing *some relation* between the supernatural and themselves. Since the religionist is part of the natural world, any such assumption amounts to making a *cognitive* claim about the world. As soon as such cognitive claim is made, religion is bound to conflict with scientific competence.

Doctrinal Incompatibilities

After having lost one battle after the other against scientific progress (White 1896), many religionists have turned 'liberal'. That is, they have stopped fighting science and have acknowledged the latter's competence in dealing with most worldly matters. (Let us, however, not forget the fundamentalists.) Apparently, there are no doctrinal conflicts left between science and religion. Many scientific theories such as those in quantum physics, electromagnetism, plate tectonics, or immunology do not pose any problems for liberal religionists. However, we submit that a clash between scientific theories and religious beliefs is bound to occur when we approach the aforementioned area of overlap between scientific and religious interests. This holds, for example, for answers to the questions concerning the evolution of the universe and, in particular, the evolution of life and *Homo sapiens*, the nature of mind, the existence of an afterlife, and the origins and social functions of religion. The answers to these questions determine whether one gets a scientific world view or an unscientific one. Let us briefly examine these examples.

Admittedly, nowadays evolution is denied altogether only by the fundamentalists – and in the United States, by roughly half the adult population. But, however liberal, religionists cannot admit that evolution has been a purely natural process (see also Rachels 1991). If consistent, they must adopt at least a minimal teleological (or design) viewpoint, that is, they must posit that the evolutionary process has been guided from above and that it has a definite purpose, particularly, to establish a relationship between humans and some supernatural entity, e.g., a deity. (The minimal postulate would be to assume that things have been endowed with an entelechy by a supernatural creator. The maximal assumption would con-

sist in occasionalism, which we shall meet again in a moment.) In adopting such a teleological and anthropocentric stance the religionist utterly distorts any scientific theories of evolution, whether cosmic or biological. This is also the main reason that a religious anthropology must remain *eo ipso* unscientific. As a matter of principle, it can never coincide with an anthropology in tune with evolutionary biology and the social sciences (see, e.g., Hernegger 1989).

The widely accepted religious notions of afterlife and reincarnation presuppose the existence of an immaterial or spiritual substance that survives the death of the body – whether it be called ‘mind’ or, on top of mind, ‘soul’. Neither neurobiology nor physiological psychology admit immaterial entities: they regard the mind as a set of brain functions (see, e.g., Bindra 1976; Bunge 1980; Hebb 1980). If this is so, then brain functions cease upon death, i.e., there can be neither afterlife nor reincarnation.

(In principle, at least the Christian can avoid this problem by adopting Joseph Priestley’s view (1776), which boils down to the theses that (a) mental functions are brain functions, so that they cease upon death, but (b) God, being omnipotent, can resurrect the dead, body *and* mind, on the Day of Judgment. Whereas (a) coincides with scientific knowledge, (b) is at odds with science at the metaphysical level because it resorts to miracles.)

Admittedly, the mind-body problem is a complex one and still a highly controversial issue among neuroscientists and philosophers. We submit, however, that only the hypothesis that mind is a set of brain functions is a scientific hypothesis (Bunge 1980). Any mind-body or, worse, soul-body dualism is an untestable and gratuitous assumption. This is the reason why no immaterial entities occur as referents in neurobiological theories. When scientists talk about an immaterial mind or a soul they engage in philosophical or theological speculation, not science (see, e.g., Eccles 1980). After all, philosophical and theological prejudice still weighs heavily on the controversy over the mind-body problem.

A conspicuous doctrinal incompatibility between science and religion is constituted by the answer to the question of the origins of religion. If consistent, religionists have to assume that their belief system originated from the contact, whether physical or spiritual, with supernatural entities at some time during human history. In marked contrast to this view the history, sociology and psychology of religion have found that religious entities are but a figment of the human imagination, so much so that nearly every society, at least since the Neolithic revolution, has created its own religion or has modified the religious beliefs borrowed from other societies. Furthermore, as already Feuerbach had suspected, it has been shown that in many cases the Olympus of a religion is a delayed representation of the social structure (see, e.g., Frankfort *et al.* 1949; Durkheim 1972; Hernegger 1989).

Thus, science does have something interesting to say about religion,

namely that its myths are in the same epistemological category as those of Aesop's and Disney's fables. The main difference between religious myths on the one hand, and poetic or cinematographic fictions on the other, is social: the former used to discharge some social function, e.g., cohesion, whereas the latter have solely some subjective, e.g., aesthetic, value. In other words, whereas religion can afford to ignore science, science knows of and explains religion. It comes as no historical surprise then that religion has adapted to science, and not the other way round (see again, White 1896).

We conclude that the degree of doctrinal incompatibility between science and religion depends on the distance from a literalist interpretation of religious doctrines, in particular sacred scriptures. The fundamentalist is prone to rejecting science altogether if it contradicts his or her dogmas. If there is no conflict, science is accepted under instrumental auspices. A well-known example is provided by the creationists who fight evolutionary biology, paleontology, geology, and other historical sciences, but pretend to argue scientifically. Clearly, their arguments are prime examples of pseudoscience (see, e.g., Kitcher 1982; Siegel 1984; Mahner 1986, 1989, 1990). Liberal religionists tend to see no conflict between science and religion at all. But if their beliefs are supposed to contain at least *some* true statements about the world, they will finally meet some of the previously listed incompatibilities. After all, the difference between fundamentalist and liberal religion is only a matter of degree, not of kind.

Metaphysical Incompatibilities

If there were no conflicts in the factual account of reality, there would still be incompatibilities at a deeper level: the set of metaphysical or ontological presuppositions of science and religion. As previously claimed, the ontology of science is a naturalist one, i.e., neither supernatural entities nor miraculous or lawless events are featured in a scientific metaphysics.

Now, naturalism is not necessarily identical with materialism but, first of all, the opposite of supernaturalism. An idealist, who believes that no real objects are material, could at the same time be a naturalist. Since full-fledged idealists are rare these days, we may disregard this option. Most people admit that some real objects are material whereas others are immaterial – which, however, is not the same as supernatural. For example, some people contend that mathematical objects, information and software programs are (somehow) immaterial, though certainly not supernatural, entities. However, since nobody has ever come up with a satisfactory conception of how material and immaterial objects may conceivably interact, we make the stronger claim that science's naturalism is a kind of materialism (Bunge 1981).

Materialism claims that all real objects are material, which is not the

same as physical. A modern version of materialism will not only regard an electromagnetic field or a photon as a material object but also a family or a society (Bunge 1977, 1979a, 1981). As for ideas, the materialist may regard them as equivalence classes of brain processes, i.e., constructs. Since, for the materialist, processes are not separable from things, a fictional object or construct has no autonomous existence. Thinking brains, not what they think, are real. The same holds for the structure of complex things or systems. Thus, for instance, a software program does not exist in and by itself. What really exists are concrete structured systems, e.g., a programmer, a computer, and a floppy-disc. These structured things may interact and, hence, elicit changes in each other, i.e., they will have different properties, hence structures, after their interaction. No immaterial entity is necessary to explain this, nor even could explain this because interaction is not defined for immaterial objects.

Unfortunately, materialism is often conflated with physicalism or reductive materialism (see, e.g., Settle 1990). However, there is also *emergentist materialism*, which not only acknowledges qualitative novelty but also admits that there are several levels of organization such as the physical, chemical, biological, social, and technological (Bunge 1979a; Blitz 1992). Since the complex entities or systems belonging to these different levels possess properties that the parts of which they are composed do not possess, i.e., so-called *emergent* properties, systems at different levels need be neither ontologically nor epistemologically reducible to entities at lower levels, i.e., to their parts, as physicalism contends. Therefore, there is no need to reject materialism just because physicalism is wrong.

How can the contention that the metaphysics of science is a materialist one be further justified? First of all, one can try to render explicit the tacit ontological presuppositions of scientific theories. To this end, it is not recommendable just to interview scientists, that is, to ask them what philosophy they believe is presupposed by their hypotheses or theories. With regard to theoretical physicists, Einstein gave the following advice: 'Don't listen to their words, fix your attention on their deeds' (1934, p. 30). If we do so with regard to scientists in general and if we also fix our attention on theories, not only deeds, it can be shown that many scientists, while doing science, not philosophy, are unfaithful to their own philosophies. For example, there is no mention of God in Newton's equations of motion, and Ernst Mach, who held a sensualist ontology and epistemology, presumably took it for granted that his instruments did not vanish when he left his laboratory (Bunge 1983b; see also Woodger 1929). In 1931 Wolfgang Pauli, though adhering to a positivist-operationist philosophy, postulated the neutrino, whose existence was then merely hypothetical, i.e., it was undetectable by any operational means required by his very own philosophy to be a meaningful concept (Vollmer 1990). Consequently, the philosopher of science who wants to reconstruct the ontology of science has to examine the theories invented or used by scientists, not

the latters' biography or weekend philosophy. If this is done, no immaterial or supernatural entities are found as the referents of scientific theories (see, e.g., Burt 1932; Bunge 1967).

This comes as no surprise because scientists cherish Ockham's famous principle *entia non sunt multiplicanda praeter necessitatem*, even if they do not always abide by it. Thus the minimal metaphysics scientists have to start with is materialist naturalism. If they want to admit supernatural entities on top of natural ones, as religionists do, they face the following problem. If we disregard the insurmountable problem of *how*, the question remains *when* and *where* shall we assume an interaction between natural and supernatural entities to occur. After all, there are only two positions that are not arbitrary. One is of course naturalism, which does not admit any supernatural entities. The other is occasionalism *à la* Malebranche or Geulinx. Occasionalism maintains that matter in itself is causally inefficacious and that God (or, in principle, any other supernatural entity) is the sole cause of every event or change in the universe. (For a detailed study of causality see Bunge 1979b.) Thus, for its conservation and action, the material or natural world is in need of the ontologically prior supernatural at any moment in time. Clearly, this position has undesirable consequences for ethics (e.g., how can there be free will, hence sin, if God is the cause of everything?), so that occasionalism hardly attracted any adherents. Not even fundamentalists are likely to subscribe to it.

A religious metaphysics that does not accept occasionalism has to propose a *via media* between naturalism and occasionalism. Whatever compromise it may put forth, however, will be judged to be an arbitrary ontological and explanatory dualism by the naturalist critic, who does not want to add any entities, moreover inscrutable ones, to his or her ontology without good reasons to do so. After all, every attempt to prove the existence of supernatural entities, in particular, gods, has failed so far (Russell 1967; Smith 1979; Mackie 1982; Martin 1990). Hence, as long as a scientific understanding of the world is possible by means of a materialist metaphysics, there is no reason to complicate it with gratuitous entities. Particularly so since the history of science shows that science was only possible after supernatural entities were eliminated from its ontology.

What, now, about those scientists who also hold religious beliefs? Doesn't the case, for instance, of Newton and Faraday prove that a scientific and religious outlook are compatible? Not at all: it is a mere *argumentum ad hominem* on the same footing as a commercial exhibiting an athlete endorsing a brand of tobacco. All it shows is that consistency of one's total system of belief is hard to come by, particular in the midst of a society where organized religion wields a formidable cultural and political power. The question of the compatibility of science and religion is a matter of methodology and metaphysics, not of history or biography. We wish to know whether the two are compatible *de jure* regardless of the compromises that individuals may work out.

As for Newton, for example, he was certainly strongly motivated and

inspired by his religious beliefs, and his conception of absolute space was indeed backed and influenced by theological consideration – a fact however, that made his musings about, not his theory of, absolute space inconsistent (Burt 1932). It comes as no surprise, then, that ‘Newton’s cherished theology was rapidly peeled off by all the competent hands that could get at him’ (Burt 1932, p. 296). Furthermore, as far as his purely scientific theories are concerned, God does not constitute a variable in any of his theories. (For an axiomatization of classical mechanics see Bunge 1967.) The ‘argument from religious scientists’ fails because it blurs the distinction between the *context of discovery* and the *context of justification*. As Popper might say, whether a religious belief, a visit to the sauna, or a sniffing of cocaine stimulates scientific discovery has no bearing on the methodological status of a hypothesis.

This, then, is the lesson that ought to be taught with regard to the religious beliefs of great (and normal) scientists: A religious metaphysics may have strongly *motivated* and *inspired* scientists from a *psychological* point of view. From a *heuristic* point of view it may have been inspiring to search for the deity’s plan of creation, i.e., to exhibit lawfulness and order in nature. From the *methodological* point of view, however, i.e., with regard to the context of justification, the situation is completely different. Either the supernatural ingredients in those former scientists’ metaphysics were never actually made use of, particularly in physics. Or, if they were made use of, as in the biology of the days of natural theology with regard to creation, they have been consistently eliminated since then. The same holds for immaterial, if natural, entities such as the entelechy or *élan vital* postulated by vitalism. Thus, even if science and religion could be shown to have been mutually compatible in Newton’s time, this would not justify the conclusion that contemporary science and religion are still metaphysically compatible. In fact, they are not.

Methodological and Attitudinal Incompatibilities

One of the main methodological requirements for a hypothesis or theory to be regarded as scientific is its testability. Testability is, first of all, a matter of principle, not praxis. That is, what matters for a hypothesis to be regarded as scientific is the possibility to tell what would count as positive (or negative) *evidence* for (or against) it. If this is impossible we have to suspend judgment as to its truth or falsity. For example, the previously mentioned neutrino hypothesis was not testable for practical, i.e. technical, reasons when proposed in 1931, and it remained in this state till 1956. But it was possible to say from the start what would count as evidence for the existence of this particle, so that suitable detectors could eventually be designed and built. In short, evidence (besides compatibility with the bulk of well-confirmed knowledge) is the arbiter for cognitive justification in science.

Without doubt, this is not the case with religion. When an allusion is

made to the testability of religious convictions, this is an instance of terminological trickery. Indeed, in the context of the philosophy of religion 'testability' has nothing to do with scientific testability because it is at the same time admitted that testability in this context means 'experiential' or 'existential', not empirical, testability (Rolston 1987). Yet subjectivity is incompatible with testability, which is supposed to be objective.

The reason why religious beliefs are untestable is that supernatural entities are inscrutable and inaccessible as a matter of principle. Whatever you do you cannot confirm or refute a hypothesis that explains an event by assuming, for instance, an occasionalist causation. Thus, supernatural explanations are all-purpose explanations, that is, they explain everything because they are consistent with whatever is discovered to be the case. For example, all the evidence against a creationist account of the world's origin cannot disprove the claim that God created the world only three minutes (or 6000 years or 5 billion years) ago with properties indicating a history it never had in order to test the strength of humans' faith (see also Mahner 1989).

Clearly, such a line of reasoning – which, incidentally, was seriously proposed by Chateaubriand and Gosse in the 19th century (White 1896) – will be ridiculed by most liberal religionists. But also the more liberal religionist faces many instances in which negative evidence does not count against articles of faith. Certainly the most famous example is the problem of evil (see, e.g., Smith 1979; Mackie 1982; Clements 1990; Martin 1990). Huge as the amount of evil and misery may be in this world, most Christians will stick to the concept of an omnipotent, omniscient and omnibenevolent God. Although this is inconsistent, it is on the other hand psychologically attractive, because the appeal to some 'higher', though ill-understood, reason for the existence of evil offers at the same time a solution to the problem of evil (Suchting 1994). This is why 'paradox' and 'inconsistency' are called 'mystery' in religion.

Another methodological incompatibility between science and religion is the latter's reliance on particular 'methods' of cognition such as intuition, revelation, or religious experience. Their characteristic is that they are inscrutable procedures, hence purely subjective ones. Thus, if such revelations or experiences are contradictory there is no possibility to decide which of the alternatives is true. From a methodological point of view then, they are not methods at all. However, whether such procedures are endorsed or not, religionists can always retreat to their faith when they wish to circumvent further rational and critical analysis. The difference between fundamentalist and more liberal religious views only lies at the point when such a retreat to fideism occurs. (For a detailed analysis of strategies to protect ideological doctrines from criticism see Albert 1981.)

Whereas the religionists' faith, i.e., the disregard and disrespect for evidence, is hailed as a virtue in their belief community, scientists are supposed to recognize that personal conviction or psychological certitude is no substitute for cognitive justification. The latter can only be achieved

by evidence. Now, the critic might attempt to rejoin that the history of science indicates that many scientists also stick to their hypotheses in an irrational manner, that they believe in them, and that they try to protect them against negative evidence. Granted. The difference, however, is that critical thinking and cognitive justification by empirical evidence belong to the ideals of the scientific community. If a particular scientist fails to comply with this ideal he or she will be blamed by his or her peers, not praised. And if a hypothesis is not accepted by the scientific community, because there is too much negative evidence counting against it and there are perhaps better alternatives available, it will not enter the fund of scientific knowledge.

Another charge has been levied against the religious attitude by Clements:

... for most supernaturalists, if supernatural realities could be understood by fully using scientific methodology, or something analogous to it, they would cease to have their special religious significance. Mystery is not simply something encountered by supernaturalists; it is, for them, essential to their religious life. Full understanding of divine matters, if it were possible, would make divine things mundane and hence incapable of sustaining religious feelings of awe and reverence. (1990, p. 134)

Thus, religionists are in a quandary: On the one hand, they have to make at least some set of cognitive assertions, e.g., about nature and human existence, in order to relate the supernatural to human affairs. On the other hand, they cannot be interested in too much knowledge because this could threaten the depth of their religious feelings. Consequently, the religionist's attitude will, contrary to the scientist's, approve of deliberate ignorance.

CONCLUSION

It should be clear from the preceding considerations that, if a religious method were applied in science, and the scientific method in religion, the result would be complete mutual destruction. Science and religion are not only methodologically different but incompatible. The same holds for the metaphysics and the ethos of science and religion. Finally, insofar as religion makes some cognitive statements about the world, there will also remain doctrinal incompatibilities between religion and science. Thus, it is plainly false that science and religion would not be in conflict at least at a deep level (O'Hear 1993). Actually, it is just at the deeper levels where the most conspicuous conflicts arise.

Science and religion can only coexist if one of them is distorted. For example, one can adopt a phenomenalist-positivist or instrumentalist view of science as, for instance, Cardinal Bellarmine, Karl Barth, Paul Tillich, or Pierre Duhem did (Bartley 1984; see also Bunge 1979b; Vollmer 1990). Or one can distort religion by adopting a mere pragmatist stance, or by regarding all of its doctrines as mere allegory or poetry without any

cognitive or truth content. Whatever ingenious conceptions of religion philosophers of religion or theologians may have worked out, we maintain that the average religious person believes that both science and religion aim at making true statements about the world. Whereas the naturalist holds that science is omniscient in cognitive matters (Bunge 1983b; Tuomela 1985), the religionist has to postulate an area in which religion is competent but science is not. Hence, what competence is assigned to science, or religion respectively, depends on the liberality of the religionist's belief system. We conclude, then, that whoever wishes to form a comprehensive and consistent world view must opt for either a religious or a scientific outlook.

SOME CONSEQUENCES FOR EDUCATION

Even in his ability to be trained, man surpasses all animals. Mohammedans are trained to pray five times a day with their faces turned to Mecca and never fail to do so. Christians are trained to cross themselves, to bow, and to do other things on certain occasions. Indeed, speaking generally, religion is the *chef d'oeuvre* of training, namely the ability to think; and so, as we know, a beginning in it cannot be made too early. There is no absurdity, however palpable, which cannot be firmly implanted in the minds of all, if only one begins to inculcate it before the early age of six by constantly repeating it to them with an air of great solemnity. For the training of man, like that of animals, is completely successful only at an early age. (Arthur Schopenhauer, 'Psychological Remarks', Section 344, p. 603)

If the religious and the scientific outlook are mutually incompatible, does it really follow that religious education and science education are mutually exclusive too? After all, if scientists manage to do good science in spite of holding religious beliefs or in spite of having been subjected to religious education, why should religious education be undesirable? One could, for instance, still make the case, as is often done, that religious education is a necessary part of moral education. Yet this possible objection does not withstand scrutiny.

First of all, it has been amply demonstrated, from Plato on, that religion cannot be the basis of morality – the second Kant notwithstanding (see, e.g., Nowell-Smith 1967; Mackie 1977; Singer 1979; Smith 1979; Bunge 1989a; Rachels 1991, as well as the journal *Free Inquiry*). Let us consider only one of the abundant arguments in favor of this thesis, which has some connection to religious education, and let us thereby restrict ourselves to

Christianity because it might be the most familiar form of religion for authors and audience.

However different religious education may be among and within Christian countries, the Bible is likely to be used, whether directly or indirectly, as a source of moral guidance. This poses a particular problem for teachers and students. As is well known, the Bible does not only contain some praiseworthy moral prescripts but also plenty of tremendously repugnant atrocities. So what is the student supposed to learn from a contradictory moral model as, for instance, exhibited by God's command not to kill on the one hand, and his favoring the death penalty, often in the form of collective punishment or even genocide, on the other? And Jesus, though usually regarded as the nice guy *par excellence*, threatens sinners with *eternal* punishment in hell, although he ought to know that human sin can only be *finite*. Another moral inconsistency is exemplified by the death of a herd of swine that Jesus causes by driving evil spirits into them (Luke 8: 32–33). Moreover Jesus enjoined his believers to desert their families (Matt. 19: 29), and promised everyone who has that more will be given him (Matt. 13:12, 25: 29; Mark 4: 25, Luke 8:18,19: 26).

If the divinity, as portrayed by the Bible, is the ultimate source of morality, then the believer, if consistent, should accept as obligatory *all* moral commandments, recommendations, or models of the Bible. But this is not what we observe, not even among fundamentalists. What we do observe is a highly selective reading of the Bible. That is, the morally acceptable parts are made use of, whereas the morally unpalatable ones are either ignored, watered down or explained away by apologetic exegesis. This strategy clearly shows that moral judgment is *prior* to Bible reading and religious education, because otherwise no such selection would be possible. The moral standard of our modern society – which, incidentally, is mostly due to the philosophical development since the Enlightenment, and not to any internal evolution of any traditional religious belief system – is projected back into the Bible, so that the morally acceptable injunctions can be rediscovered in it and believed to originate in the divine (Bugge 1992). 'Eisogesis' has been aptly termed that skill of reading out of a text the interests one reads into it (Smith and Hoffmann 1989, p. 241).

Furthermore, the strategy of selective Bible reading reveals another instance of incompatibility between the religious versus the scientific attitude and value system. Whereas students of religion are encouraged to select the evidence as admitted by their belief community, scientists commit a severe sin if they use selective evidence. Scientists are supposed to follow the evidence wherever it may lead them. This may even lead to the rejection of a favorite hypothesis. Christians, on the other hand, will usually not reject the Bible as a moral guide, since they are allowed to pick whatever items their particular belief community favors. It goes without saying that the multitude of religious groups and affiliations clearly indicates the arbitrariness of this attitude.

Another case must be made against religious education as a form of moral education. The goals of a modern moral education compatible with a scientific one include acquiring the attitude and the capability to modify one's moral principles in the light of new experience, knowledge and insight (Martin 1991). This aim is certainly perpendicular to the religious attitude towards moral norms. If moral norms are God-given, they cannot be questionable or modifiable. Religionists can only obey or disobey them, i.e., they are *behaviorally* autonomous at best. If religionists were to alter some moral rules, they would, at least tacitly, admit that the divinity is not the source of these rules, but that human beings are *morally* autonomous.

The preceding examples lead to one of the main arguments against religious education. We admit that the scientist who holds religious beliefs may be able to come to terms with the metaphysical and methodological incompatibilities involved, though only at the price of inconsistency. However, if one is concerned with the education of the public, then the teaching of the religious attitude and value system can only have detrimental effects for adopting a comprehensive scientific outlook and critical attitude. For, (a) if having faith without evidence or even contrary to evidence is taught to be a virtue, (b) if the suspension of critical thinking is, at least tacitly, taught to be admissible whenever convenient to accept and save a belief, (c) if myth or fiction is not distinguished from confirmed hypothesis, and (d) if the acceptance of a (usually anachronistic) moral system based on authoritarianism is encouraged, then this is likely to be a considerable factor why many people all over the world (still) fall prey to obscurantists, charlatans and crackpots such as, e.g., New Agers, astrologers, quack physicians, irrationalist philosophers and, worse, crank politicians and war mongers (Kurtz 1986; Bunge 1989b). After all, those in power have never been truly interested in too critical a people. Furthermore, confronted with the unprecedented social, economic, environmental, and moral problems of our world, the religious attitude may lead people to look for moral and practical guidance in sources where there can be no answer, namely unscientific and authoritarian belief systems, old or new (see also Bunge 1989a). Worse, it may lead people to be content with inaction when action would be necessary. For example, resorting to religious 'methods' of 'action' such as prayer is a most unsuitable means of changing the world. Finally, one may suspect that most traditional religions, however liberal at a certain time, contribute to providing a steady, if only latent, source of authoritarianism, intolerance and undemocratic outlooks, as suggested by the occasional revival of fundamentalist groups all over the world. (See also Russell 1967.) The reason is that the values of a modern enlightened, pluralistic and democratic society just cannot be found in ancient religious doctrines (except maybe by eisogesis), or attributed to a religious outlook. We submit that religion will only remain liberal as long as it is kept in check by science and enlightened secularism. For this reason religion and science can only coexist in truce, not peace.

Is this thesis exaggerated? We do not deny that many religious people

have been motivated and inspired by their beliefs to do marvellous social and cultural (including scientific) work (see, however, Russell 1967). But many religious people have also been motivated by their beliefs to persecute and kill millions of other, equally religious, people: pagans, heretics, witches, and fellow believers. Since more often than not religion is presented in an overall positive light, it seemed appropriate to counter such selective presentation by a more critical one. In doing so, our aim was to point out where science and religion are in conflict: the doctrinal, metaphysical, methodological and attitudinal level. Since science education as well as moral and religious education are supposed not only to convey propositional knowledge but also to elicit and develop a certain attitude or mentality in our children (see, e.g., Bunge 1989b; Martin 1991), we come to the conclusion that, regarding the incompatibility of the scientific and religious attitude, a religious education, particularly at an early age, is a most effective obstacle to the development of a scientific mentality.

Note that, in defending this thesis, we do not claim that religious education is a *necessary* obstacle to the development of a scientific mentality. Every scientist with a religious education (including the junior author) is living proof to the contrary. Yet religious education is an impediment in the sense that it has to be overcome, to be repressed or forgotten, in order to develop a scientific mind. At least the person in question must, at the price of inconsistency, be able to ignore his or her religious metaphysics, value system and attitude in order to do, and while doing, science. All this is of course possible. But religious education is also an obstacle in the statistical sense that the majority of people are not able to overcome early childhood indoctrination. (In this sense, Schopenhauer's statement above is correct.) So why should we expose our children to an education that has to be given up or at least ignored anyway? And why should we expose our children to an education that fails in providing a moral education and, worse, that can be shown even to impede moral development (Clouse 1985, Clark 1994)? In sum, we submit that we can only make social and moral progress by dropping religious education.

SOME CONSEQUENCES FOR EDUCATION POLICY

From a scientific and secular point of view, one can easily deplore the amount of religious education, whether tacit or explicit, that our children are exposed to. If one maintains at the same time that religious freedom is a human right, this clearly forbids us to interfere with private religious education by any paternalistic means. We can only resort to education in order to diminish the amount of private religious education. A serious moral problem, however, is posed by a strict fundamentalist education, for there are good reasons to regard the latter as a form of child abuse

(Siegel 1984.) Although this issue deserves more consideration, we cannot pursue it here.

Let us therefore turn to public education, where the situation is different in that we have, in principle, the legal options to decide what ought to be taught in public schools. The following suggestions are natural consequences of our previously expounded view, so that we do not have to defend them by further argument. It should be noted that they, in principle, can be shared by someone who disagrees with our view on the incompatibility of science and religion.

We contend that in public schools no teaching of religion from a religious point of view should be allowed, because such schools are supposed to form and inform, not to indoctrinate at the tax-payer's expense. (Clearly, this proposal presupposes that the state is religiously neutral.) Neither are religious symbols to be displayed, nor religious activities, such as school prayers, are to take place. Religious education and activity has to remain a completely private affair. The curriculum ought to promote the teaching of scientific knowledge and methodology as well as the teaching of the scientific attitude and value system. (Interestingly, this is often associated by critics with a certain 'dry' or 'sterile rationality' or, in other words, with a lack of sentiment, imagination, marvel, awe and fun. We believe this is a prejudice and has nothing to do with science education in principle but only reflects the bad state of science education that most of us have received. (For textbooks attempting at making a scientific and critical attitude accessible to children see, e.g., Barker 1990 (ages 9+); Brockman 1989 (ages 5+); Ruchis 1991 (ages 12–15).)

Concerning the teaching of religion, only the scientific view of religion is to be expounded in history and social science classes. No doubt, this is a most delicate challenge for teaching, didactics and education, because it will cause a conflict in those students receiving a private religious education. Only in philosophy classes may the religious world view be considered as an alternative to a scientific world view.

Although the religious convictions of students and their parents should be respected, the aims of modern education clearly take precedence over religious interests and rights. For instance, parents should not be permitted to remove their children from certain classes, such as sex education and evolutionary biology.

As for private schools that are supposed to function as substitutes for public ones, the question arises whether they should be permitted at all. Assuming that they are permissible, it should be secured that the curriculum is basically identical to the public one. Students should be able to pass a standardized final exam. In secular states public funding should be restricted to those private schools whose outlook is similar to the public ones, or that attempt to explore an alternative pedagogy which is in tune with education science, such as, for instance, Montessori pedagogy. Neither religious private schools nor schools whose pedagogic outlook is based on a quasi-religious or pseudoscientific outlook, such as the

anthroposophical *Waldorf* schools, should receive any public funding. (For more on the latter see, e.g., Hansson 1991; Dugan and Daar 1994.) The French, by the way, adopted this policy long ago and are still prepared to fight for it, as could be seen at the beginning of 1994.

As for public universities, there is no reason to maintain theological faculties. The study of religion ought to be done scientifically, that is, by historians, psychologists and social scientists as well as philosophers. Although a scientist or philosopher may be privately committed to a particular religion, a committed or affiliated faculty in a public university is an anachronism.

May the preceding considerations, which are likely to provoke and outrage some readers, contribute to a healthy discussion of the widely overlooked, skirted or downplayed conflict between religious education and science education.

REFERENCES

- Albert, H.: 1981, *Traktat über kritische Vernunft*, J.C.B. Mohr (Paul Siebeck), Tübingen (English translation (1985), *Treatise on Critical Reason*, Princeton University Press, Princeton, New Jersey).
- Barker, D.: 1990, *Maybe Yes, Maybe No. A Guide for Young Skeptics*, Prometheus Books, Buffalo, New York.
- Bartley, W.W.: 1984, *The Retreat to Commitment*, Open Court Publishing Company, La Salle, Illinois.
- Bindra, D.: 1976, *A Theory of Intelligent Behavior*, John Wiley, New York.
- Blitz, D.: 1992, *Emergent Evolution. Qualitative Novelty and the Levels of Reality*, Kluwer Academic Publishers, Dordrecht.
- Brockman, C.: 1989, *What About Gods?*, Prometheus Books, Buffalo, New York.
- Buggle, F.: 1992, *Denn sie wissen nicht was sie glauben*, Rowohlt, Reinbek.
- Bunge, M.: 1967, *Foundations of Physics*, Springer Verlag, New York.
- Bunge, M.: 1977, *The Furniture of the World: Ontology I*, D. Reidel, Dordrecht.
- Bunge, M.: 1979a, *A World of Systems: Ontology II*, D. Reidel, Dordrecht.
- Bunge, M.: 1979b, *Causality in Modern Science*, 3rd ed., Dover, New York.
- Bunge, M.: 1980, *The Mind-Body Problem*, Pergamon Press, Oxford.
- Bunge, M.: 1981, *Scientific Materialism*, D. Reidel, Dordrecht.
- Bunge, M.: 1983a, *Exploring the World: Epistemology & Methodology I*, D. Reidel, Dordrecht.
- Bunge, M.: 1983b, *Understanding the World: Epistemology & Methodology II*, D. Reidel, Dordrecht.
- Bunge, M.: 1988, 'Ideology and Science', in G.L. Eberlein & P.H. Berghel (eds.), *Theory and Decision. Essays in Honor of Werner Leinfellner*, D. Reidel, Dordrecht. pp. 79–89.
- Bunge, M.: 1989a, *Ethics – The Good and the Right*, D. Reidel, Dordrecht.
- Bunge, M.: 1989b, 'The Popular Perception of Science in North America', *Transactions of the Royal Society of Canada*, Series V, 4, 269–280.
- Burtt, E.A.: 1932, *The Metaphysical Foundations of Modern Physical Science*, Routledge & Kegan Paul, London.
- Clark, B.: 1994, 'How Religion Impedes Moral Development', *Free Inquiry* 14(3), 23–25.
- Clements, T.S.: 1990, *Science vs. Religion*, Prometheus Books, Buffalo, New York.
- Clouse, B.: 1985, 'Moral Reasoning and Christian Faith', *Journal of Psychology and Theology* 12, 190–198.

- Dawkins, R.: 1993, 'Viruses of the Mind', *Free Inquiry* 13(3), 34–41.
- Dugan, D. & Daar, J.: 1994, 'Are Rudolf Steiner's Waldorf Schools 'Non-Sectarian'?', *Free Inquiry* 14(2), 44–47.
- Durkheim, E.: 1972, *Selected Writings*, edited by A. Giddens, Cambridge University Press, Cambridge.
- Eccles, J.C.: 1980, *The Human Psyche*, Springer International, New York.
- Edwards, P. (ed.): 1967, *The Encyclopedia of Philosophy*, The Macmillan Company & The Free Press, New York; Collier-Macmillan, London.
- Einstein, A.: 1934, *The World As I See It*, Covici-Friede, New York.
- Frankfort, H., Frankfort, H.A., Wilson, J.A. & Jacobsen, T.: 1949, *Before Philosophy: The Intellectual Adventure of Ancient Man*, Penguin Books, Harmondsworth.
- Hansson, S.O.: 1991, 'Is Anthroposophy Science?', *Conceptus* 25(64), 37–49.
- Hebb, D.O.: 1980, *Essay on Mind*, Erlbaum, Hillsdale, New Jersey.
- Hernegger, R.: 1989, *Anthropologie zwischen Soziobiologie und Kulturwissenschaft*, Habelt, Bonn.
- Kanitscheider, B.: 1993, 'Las Ciencias y el Más Allá. Ideas para Establecer una Convivencia Armoniosa', *Folia Humanistica* 31, 497–516.
- Kitcher, P.: 1982, *Abusing Science: The Case Against Creationism*, MIT Press, Cambridge, Massachusetts.
- Kurtz, P.: 1986, *The Transcendental Temptation. A Critique of Religion and the Paranormal*, Prometheus Books, Buffalo, New York.
- Mackie, J.L.: 1977, *Ethics. Inventing Right and Wrong*, Penguin Books, Harmondsworth.
- Mackie, J.L.: 1982, *The Miracle of Theism. Arguments for and against the Existence of God*, Clarendon Press, Oxford.
- Mahner, M.: 1986, *Kreationismus – Inhalt und Struktur antievolutionistischer Argumentation*, Pädagogisches Zentrum, Berlin.
- Mahner, M.: 1989, 'Warum eine Schöpfungstheorie nicht wissenschaftlich sein kann', *Praxis der Naturwissenschaften – Biologie* 38(8), 33–36.
- Mahner, M.: 1990, '"Wissenschaftlicher Kreationismus" – Eine Pseudowissenschaft mit religiösem Hintergrund', *Skeptiker* 3(3), 15–20.
- Margenau, H. & Varghese, R.A. (eds.): 1992, *Cosmos, Bios, Theos*, Open Court La Salle, Illinois.
- Martin, M.: 1990, *Atheism - A Philosophical Justification*, Temple University Press, Philadelphia.
- Martin, M.: 1991, 'Science Education and Moral Education', in Matthews (ed.), pp. 102–113.
- Matthews, M.R. (ed.): 1991, *History, Philosophy and Science Teaching: Selected Readings*, OISE Press, Toronto, Teachers College Press, New York.
- Matthews, M.R.: 1992, 'History, Philosophy, and Science Teaching: The Present Rapprochement', *Science & Education* 1, 11–47.
- Merton, R.K.: 1973, *The Sociology of Science. Theoretical and Empirical Investigations*, University of Chicago Press, Chicago.
- Nowell-Smith, P.H.: 1967, 'Religion and Morality', in Edwards (ed.), Vol. 7, pp. 150–158.
- O'Hear, A.: 1993, 'Science and Religion', *British Journal for the Philosophy of Science* 4, 505–516.
- Priestley, J.: 1776, *Disquisitions Relating to Matter and Spirit*, Arno Press, New York.
- Rachels, J.: 1991, *Created from Animals. The Moral Implications of Darwinism*, Oxford University Press, Oxford.
- Rolston, H.: 1987, *Science and Religion. A Critical Survey*, Random House, New York.
- Ruchlis, H.: 1991, *How Do You Know It's True? Discovering the Difference Between Science and Superstition*, Prometheus Books, Buffalo, New York.
- Russell, B.: 1967, *Why I am not a Christian*, George Allen & Unwin, London.
- Schopenhauer, A.: 1974, *Parerga and Paralipomena. Short Philosophical Essays*, Vol. 2, translated by E.F.J. Payne, Clarendon Press, Oxford.

- Settle, T.: 1990, 'How to Avoid Implying that Physicalism is True: A Problem for Teachers of Science', *International Journal of Science Education* **12**, 258–264.
- Siegel, H.: 1984, 'The Response to Creationism', *Educational Studies* **15**, 349–364.
- Siegel, H.: 1989, 'The Rationality of Science, Critical Thinking, and Science Education', *Synthese* **80**, 9–41.
- Singer, P.: 1979, *Practical Ethics*, Cambridge University Press, Cambridge.
- Smart, J.J.C.: 1967, 'Religion and Science', in Edwards (ed.), Vol. 7, pp. 158–163.
- Smith, G.H.: 1979, *Atheism – The Case Against God.*, Prometheus Books, Buffalo, New York.
- Smith, M. & Hoffmann, R.J. (eds.): 1989, *What the Bible Really Says*, Prometheus Books, Buffalo, New York.
- Suchting, W.A.: 1994, 'Notes on the Cultural Significance of the Sciences', *Science & Education* **3**, 1–56.
- Tuomela, R.: 1985, *Science, Action, and Reality*, D. Reidel, Dordrecht.
- Vollmer, G.: 1990, 'Against Instrumentalism', in P. Weingartner and G.J.W. Dorn (eds.), *Studies on Mario Bunge's Treatise*, Rodopi, Amsterdam, pp. 245–259.
- White, A. D.: 1896, *A History of the Warfare of Science with Theology in Christendom*, Prometheus Books, Buffalo, New York, 1993.
- Wolpert, L.: 1992, *The Unnatural Nature of Science*, Faber and Faber, London.
- Woodger, J.H.: 1929, *Biological Principles*, Routledge & Kegan Paul, London; Humanities Press, New York, 1967.
- Woolnough, B.E.: 1991, 'Faith in Science', in Matthews (ed.), pp. 218–224.